Comments on Proposed Rulemaking FHWA Docket No. FHWA-2001-8954
National Bridge Inspection Standards

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Application of Standards:

The NBIS is adequate for highway bridges, but there are many other structures over or adjacent to highways that can affect public safety, including railroad bridges, and overhead traffic signs.

There are no national standards mandating inspection of railroad bridges, whether they carry freight or passenger trains. The specifications of the American Railway Engineering and Maintenance of Way Association (AREMA) only provide vague guidance as to the extent of inspections in the form of "recommended practice" which is interpreted and applied differently by the various large railroads, short lines, and transit agencies, and no guidance as to the qualifications of railroad bridge inspectors. These railway bridges are subject to the same distress and damage as highway structures, if not more, because of the heavier loads, and their management system is generally much leaner that highway agencies. While there have not as yet been well-publicized railroad bridge failures, railroad structures passing over highways, and railroad bridges carrying hundreds of passengers or hazardous materials have the potential, if they fail, for large loss of life. Railroad bridges should be required to meet at least the same inspection standards as highway bridges. The NBIS should be extended to include railroad bridges.

The NBIS should also be extended to include all bridges, whether for vehicles or pedestrians, whether publicly or privately owned, if the public may have access to them. For example, bridges within private parks and entertainment facilities which are used by the public should be specifically subject to the NBIS.

Sign structures have collapsed in a number of states, resulting in at least some deaths. States that have initiated a sign structure inspection program have found significant structural defects in many signs, and many signs have been removed on an emergency basis. Those states that have initiated sign inspection programs have all developed slightly different systems for inspection and rating of the structures. Because, if these structures fail, there is a significant potential for loss of life, all states should required to inspect their sign structures and develop a sign structure management system. If national standards were established, such as part of the NBIS, this would save the states the cost of developing individual systems.

Inspection Procedures

It has been our firm's experience that underwater inspections of bridges at maximum intervals of four to six years may be satisfactory for bridges in good condition, in benign environments, and we have observed that many agencies schedule underwater inspections to coincide with the biennial inspection of the bridge. For structures located in aggressive environments, or for structures constructed of materials which are more subject to deterioration, the interval should be reduced. For example, for timber bridges located in salt water environments where marine borers are present, for steel structures located in salt water or brackish environments, or in areas where there is a potential for scour, the interval should be reduced. We have found many instances of significant deterioration or physigal damage which has occurred within less than five years.

The determination of when the underwater portions of a structure can be inspected by wading and when it must be inspected by a diver varies from state to state. Some states have adopted arbitrary depths as the point beyond which a diving inspection is required. Such arbitrary limits may not ensure that an inspection is conducted in all cases where there may be significant underwater damage or distress. It is recommended, that the team leader conducting the routine above water inspection be made responsible for determining if a diving inspection is required. If the above water team leader cannot, or does not, inspect all underwater portions of the structure by wading and probing, and he cannot form an opinion, with reasonable certainty, that the structure is safe below water, he should, in rating the bridge condition, require that a diving inspection be required. This would place the responsibility on the inspector to ensure an underwater inspection is conducted if it is necessary.

Our firm has found that the scope of above water and underwater inspections vary greatly from agency to agency. For example, some agencies allow what amounts to "windshield" above water inspections while others examine the structure closely. Some agencies have comprehensive underwater inspection programs while others look at as few structures as possible. The NBIS should be revised to clarify the level of inspection effort that is required for both the routine above water inspection and for the underwater inspection. It should indicate that the inspections must be conducted at "arm's length." In above water inspections, this will ensure that access equipment, such as ladders and snoopers, are used when necessary to look at bridge details. In the below water inspections, this will ensure that agencies are not able to justify using soundings in place of a true underwater inspection.

The NBIS should also clarify that the team leader must be present at the site and perform a significant portion of both above water and underwater inspections. Office review of inspection reports or coordination of the field inspection crews should not be considered fulfilling the requirement for a qualified team leader.

Qualification of Personnel

There is currently no minimum training required for a bridge inspection team member. It is recommended that the minimum training be either completion of an 80-hr comprehensive course based on the Bridge Inspectors Training Manual (BITM) or graduation from a 4-year accredited civil (structural) engineering curriculum.

The bridge inspection team leader is responsible for making an evaluation of the safety of the bridges he inspects. Public safety and millions of dollars in assets depend on that judgement. Every state has professional licensing laws that would require such an important evaluation of a structure to be made by a professional engineer licensed in that state, except that the NBIS allows such evaluations of bridges to be made by less qualified persons, persons who do not meet the minimum professional licensing requirements. The situation is even worse for railroad bridges, where there are no specific qualifications in AREMA for bridge inspectors.

Professional engineers have an ethical and legal obligation to perform bridge inspections competently and to protect the public interest. Unlicensed bridge inspectors and team leaders have no such obligation and cannot be held to the same legal standards. In order to improve the professionalism of bridge inspection, it is recommended that the NBIS be amended to require that team leaders be licensed professional engineers in civil or structural engineering.

The need for minimum professional qualifications for underwater inspectors is even greater since the underwater structure cannot be easily inspected other engineers above water. In fact, the U.S. Navy, a number of bridge owners, and the American Society of Civil Engineers (ASCE), have all recognized the importance of the underwater inspector's qualifications. The U.S. Navy, an organization which has more divers than any other in the world, requires that their underwater facilities assessments, conducted world-wide, be performed by licensed professional engineer-divers (at least 50% of the underwater inspection) assisted by graduate engineer-divers. A survey conducted by the Underwater Structures Inspection and Maintenance Subcommittee of the Transportation Research Board a few years ago found that about two thirds of the states that retain outside contractors for underwater inspections consider the services to be a professional services contractor. The majority of major bridge engineering firms, recognizing the importance of underwater bridge inspections, and the potential liability incurred by using unlicensed engineers, retain engineering firms that use professionally licensed engineer-divers.

In April, 2001, ASCE published *Underwater Investigations, Standard Practice Manual,* which provides guidelines and methods for conducting underwater engineering assessments of waterfront facilities. The manual deals with the technical qualifications of inspectors, and technical inspection and assessment methods. It states that "the underwater inspection team shall be led by and under the direct on-site supervision of a team leader who shall be a registered, licensed professional civil or structural (or related) engineer. The team leader shall be a trained diver and shall participate actively in the inspection by personally diving to conduct a significant portion (minimum of 25%) of the diving inspection work. The team leader shall have a minimum of 5 years experience conducting underwater structural inspections and a minimum of 5 years engineering experience specifically related to the type of facility under investigation." The manual also states that any "team members involved in inspection, note-taking, and documentation work shall be trained divers who are graduates of a 4-year engineering curriculum and have been certified... as an engineer-in-training (EIT)... or technician divers who have completed a course of study in structural inspections...."

In any structural inspection, whether above or below water, there are two elements critical to success: the expertise of the inspector and the comprehensiveness of the inspection. In the case of the underwater inspection, the method of access, generally diving, is the key to the comprehensiveness. Although a certain level of diving competency is necessary such that the inspector is able to conduct the inspection without resulting in injury or death, it should be borne in mind that diving is only a method of access to get the trained inspector to the underwater site, just as a snooper truck is a method of access to the underside of a bridge. A sign that hung above the entrance to a west coast diving school may have said it best: *Diving is not a panacea for the skills you lack. It is only a unique form of transportation.* The critical skill involved in underwater evaluations is engineering judgment, while the diving is only a facilitator for the engineer's efforts.

The inspector must possess both diving (access) skills and inspection skills. The diving skills necessary to conduct an underwater inspection will depend upon the water environment in which the structure is located. Most structures, at least the exposed portions of them, are located in relatively shallow water. For example, probably three fourths of all bridges are located in water less than fifty feet deep, and probably more than half of all bridges are located in water twenty-five feet or less in depth. Although it can be severe, the diving environment for such structures is generally not, and a reasonably competent diver will be able to dive in the vast majority of underwater inspection situations.

In evaluating structures underwater, the need for the engineer's special training is even more important than above water. Above water, it is easier for more than one engineer to participate in a structural inspection. It is also relatively easy to return to a facility to reexamine conditions and confirm initial observations. The underwater structural inspection, however, is more difficult to accomplish, at times more costly to conduct, and the site cannot be easily revisited by either the original inspector or other inspectors. The below water inspection, therefore, must be designed so that it can be performed with the necessary expertise and economy.

Because of educational background, experience in engineering tasks besides inspection such as analysis and design, and developed problem-solving skills, the structural engineer-diver operates at a level well above that of a construction diver, who is basically a tradesman without engineering training. Examination of all underwater portions of a structure in minute detail could be costly, but by knowing what to look for and recognizing the structural importance of unexpected and unusual conditions, the engineer can reduce that cost. The engineer also has the distinct ability to identify and concentrate on the more structurally critical locations of an underwater facility, as well as those areas more prone to structural problems. The advantages gained by using an engineer, who is a competent diver, are particularly clear when the diving conditions are adverse and "bottom time" is at a premium. The engineer can quickly evaluate what has been encountered and spend the time commensurate with the conditions found. This generally results in overall underwater inspection costs lower than those resulting from the use of a construction diver.

It has been our experience that construction divers generally are able to find the common defects in underwater structures, such as obvious deterioration or damage, but because of a lack of understanding for the engineering principles involved, they do not recognize the significance of the conditions they encounter. On occasion, this has lead to "red flags" being raised because of conditions, which although may have been widespread, were of little structural significance.

Conversely, this has also resulted in a failure to recognize anomalous conditions which would cause an engineer-diver to further investigate other portions of the structure in greater detail.

In the past, some underwater structural inspections have been conducted using construction divers reporting to an engineer on the surface. This has proven to be less than ideal, not to mention that the engineer must rely on the relayed information to make important engineering judgments. If the construction diver is not technically trained; that is, not an engineer, then there is a good possibility that conditions which are important to the engineer will not be recognized. Even with underwater video cameras, the engineer on the surface can only rely on the information that gets transmitted to the surface. In much the same way that an engineer would not be satisfied with an inspection conducted by an ironworker climbing a structure and reporting his findings by radio to the engineer on the ground, using a construction diver as an “interface” is not sufficient for conducting underwater engineering evaluations. If the construction diver does not point the camera at the most important conditions, the engineer on the surface will not know of them. Furthermore, even when the correct visual images are available, they cannot convey data normally gained by feeling the response to probing, sounding, or other tactile techniques. In addition, water conditions are often such that visibility is negligible, and the proper identification of underwater conditions rests solely on the tactile skills of the inspector. The limitations of this relayed information type of examination are evident. It would be similar to a patient being examined by a nurse or medical technician, who then telephones a doctor in the next room, who then makes the medical evaluation. There is no substitute for the hands-on examination of a professional engineer.

impacts from vessels or floating debris. Once having been given the task to conduct such underwater investigations, the structural engineer then has the professional responsibility to provide services in a thorough, accurate, and safe manner. The aforementioned use of unqualified construction divers as a critical link in the underwater engineering evaluation process, however, does not fulfill that responsibility.

Only a properly trained and experienced engineer-diver can bring an intimate structural understanding to the below water inspection, whereas the construction diver merely reports what may be found without interpretation. The use of construction divers also exposes an above water engineer in responsible charge of a project to greater liability. A construction diver has no legal standing as an expert in structural evaluations, as well as no professional duty to the public to properly conduct structural inspections and evaluations. If the construction diver does not recognize important conditions underwater or does not properly report those conditions to the engineer, it is the above water engineer who is ultimately responsible.

Based on the findings, the underwater structural engineer then becomes responsible for the appropriate evaluation of the conditions encountered, and insuring that the facility’s owner or the above water engineer fully understand the meaning of the assessment and what may be required to safeguard structural integrity. Since it is only the underwater engineer who has been directly in contact with the below water conditions, it is even more essential that the conclusions reached and the measures recommended are accurately and convincingly presented. Given the intimate knowledge of the conditions and the expertise to know what needs to be done to rectify them, the structural engineer is again ideally suited to continue the underwater engineering process by providing the necessary remedial or replacement designs. The level of responsibility for the underwater designs is enhanced, however, since there is exclusive trust placed in the underwater engineer's recommendations, which involve aspects hidden to all others and unique by virtue of the underwater environment.

The underwater engineer's responsibilities, however, do not stop after completion of the design and selection of an underwater contractor. There is also the responsibility to insure that the underwater work is completed in full compliance with the design, by stressing the importance of timely underwater inspections during the construction period. Similar to the original conditions, the work being done and its quality are hidden, and the underwater engineer must act as the owner's or the above water engineer's eyes to insure, that which is only accessible to the contractor and the underwater engineer, is fully acceptable.